Wetting Front

Water Management Research Unit Newsletter

Vol. 2, No. 2 USDA-ARS Conservation and Production Research Laboratory November 1998

P.O. Drawer 10 ! Bushland, Texas 79012-0010 U.S.A.

(806) 356-5724 ! FAX (806) 356-5750 ! 2300 Experiment Station Road

Drip Irrigated Soybean Production — Southern High Plains . . .

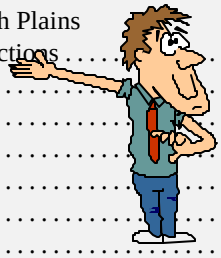
by Steve Evett

Soybean is becoming an important crop in the Texas High Plains. Irrigated soybean planting increased from 20,700 acres in 1974 to 74,000 acres in 1997 in the Northern and Southern Texas High Plains. In the Southern Texas High Plains, soybean is often a catch crop replacing cotton. Though irrigated cotton usually does not fail due to poor germination, it may fail due to hail, damage from wind blown sand, or excessive rain. Further north, soybean figures into an irrigated soybean/corn rotation. The development of genetically designed cultivars with herbicide resistance such as "Roundup Ready" soybean allows soybean to be used as a rotation crop to better control grassy weeds. Also, the swine industry expansion in the U.S. Southern High Plains has provided an improved local market. Data on soybean irrigation methods, water use, yield, and water use efficiency (WUE) are scarce for the Southern High Plains.

Figure 1. Exergen model Irt/c.2-T-80 thermocouple type infrared thermometer enclosed in a white PVC plastic case to reflect short wave radiation and lessen sensor heating.

Irrigation scheduling is most commonly accomplished with one of two important methods. One method involves measuring the soil profile water content and then irrigating to fill the profile in the rooting zone to field capacity. Howell et al. (1997) reported that weekly soil water replenishment using this method prevented stress of irrigated corn on the Pullman clay loam at Bushland, TX, and that a three-day irrigation cycle had no significant advantage. The other method uses a crop coefficient (K_C) multiplied by a daily reference evapotranspiration value (ET_R) to calculate a daily crop water use estimate as K_cET_R. The crop coefficient is usually available as a function of crop growth stage or growing degree days since emergence. The ET_R value is calculated from weather station data. An example of this method is the daily crop water use estimates published by the North Plains PET Network, a joint project of USDA-ARS and Texas Agricultural Experiment Station & Texas Agricultural Extension Service, Amarillo/Bushland, TX. Irrigations may be scheduled based on these crop water use estimates and local measurements of rainfall. Both methods have disadvantages that hinder wide spread adoption. Repetitive measurement of soil water content is time consuming and costly. Crop water use estimates require a weather station not too far away and local measurements of rainfall. Some soil profile water content measurements are still needed with the K_CET_R method because the water use estimates are just that, *estimates*, and field soil water may gradually differ from the optimum desired. With both methods, management time is still needed to calculate irrigation amounts for various fields.

INSIDE



Several automatic irrigation systems have been developed to reduce the management and measurement time needed to schedule irrigations. Some systems use automatic soil water content (e.g., Lascano et al., 1996) or soil water potential measurements. Others use crop leaf (canopy) temperature measurements in a feedback loop to control irrigation. The BIOTIC system, developed by USDA-ARS in Lubbock, TX, uses a species-specific canopy temperature threshold and a region-specific time threshold (Wanjura et al., 1995). If the crop is warmer than its threshold temperature for longer than the threshold time in a given day, it is irrigated an amount equal to the peak daily water use rate for that crop. We performed an experiment to evaluate the BIOTIC system with drip irrigated soybean and compared the system with traditional irrigation scheduling that used soil profile water content measurements. We also sought to measure the crop yield response to irrigation amount and to seasonal crop water use, and to measure water use efficiency.

MATERIALS AND METHODS

Soybean [*Glycine Max* (L.), var. Pioneer 9481, late maturity group 4] was planted on 2 May 1996, after Treflan was applied at one quart/acre and incorporated, at the USDA-ARS Conservation and Production Research Laboratory, Bushland, TX. Emergence was completed on 8 May 1996 and physiological maturity was reached by 7 Sept. 1996. The soybeans were ready for harvest on 18 Sept. 1996 and hand samples were taken from side-by-side 15-foot rows in each subplot. The soil is a Pullman clay loam (fine, mixed, thermic Torrertic Paleustoll). The research site consisted of 21 plots, each 34 by 89 feet, with 12 crop rows at 30-inch spacing in each. Subplots had either buried or surface drip tubing installed. One half of each plot had drip tubing buried at 12-inch depth in every other interrow (60 inch spacing). The other half had surface drip lines laid in every other interrow. Tubing (Typhoon T25-0.6-18, Netafim Irrigation Inc., Fresno, CA) had pressure compensating emitters (0.6 gal/h flow rate) spaced at 18 inches. Flow to each plot was regulated to 4 gpm using Dole valves. Irrigation to each plot was controlled using back-to-back Rainbird 3/4 in. solenoid valves. For nine plots, these were connected to a Rainbird controller. The other 12 plots were controlled by the BIOTIC system controller, which consisted of a datalogger/microcontroller (21x, Campbell Scientific Inc (CSI), Logan, UT) connected to a 16-channel relay module (CSI model SDM-CD16AC). The relay module in turn controlled 24 VAC power between a bank of 120VAC/24VAC transformers and the solenoid valves. Canopy temperature was measured by a thermocouple type infrared thermometer (IRT) (Exergen model Irt/c.2-T-80, Watertown, MA) (Fig. 1) mounted on a pole in each plot and connected to the datalogger. Phosphoric acid was continuously injected into the irrigation water at 5.3 mg/L to prevent plugging.

The five months before planting were virtually devoid of rain (0.2 inches total) and the soil at planting depth was very dry. A pre-plant irrigation of 3.6 inches was applied, but this was not enough to germinate all seeds. Additional irrigations averaging 8 inches were required in May for complete germination. We have noticed that in years with below normal late winter and spring rainfall that it is difficult to germinate all seeds with drip irrigation on the Pullman soil. This soil cracks deeply and water movement is prevented across cracks until the soil swells enough to close the cracks. Even when tillage closes cracks at the surface, the cracks remain subsurface and prevent lateral water flow. In the past four years, we have had this problem every other year.

Seven irrigation scheduling treatments were applied to the 21 plots, resulting in three replicate plots for each treatment (Table 1). A randomized block plot spatial design was applied. Two threshold temperatures were used, each with two threshold times. The 80.6EF (27EC) threshold temperature was calculated at the ARS Plant Stress Laboratory on the basis of the temperature kinetics of soybean photosynthetic enzymes. To apply a slightly more stressful irrigation regime, we used a second threshold of 84.2EF (29EC). The threshold time is the mean daily time during the irrigation season that a well-watered crop canopy is above the threshold temperature. For this definition of threshold time, the irrigation season begins when the canopy is developed enough for its temperature to be measured. For soybean grown under sprinkler irrigation at Bushland in 1995, the threshold times were 256 min and 171 min for threshold temperatures of 80.6EF (27EC) and 84.2EF (29EC), respectively, and the peak water use was 0.4 in./d (10 mm/d). The four treatments, resulting from combining two threshold

Wetting Front is published semi-annually (May and November) and distributed by the USDA-ARS, Conservation and Production Research Laboratory, Water Management Research Unit, P.O. Drawer 10, Bushland, TX 79012-0010.

Editor: Dr. Terry A. Howell, P.E.
USDA-ARS
P.O. Drawer 10
Bushland, TX 79012-0010
e-mail: tahowell@ag.gov
Phone: (806) 356-5746
Fax: (806) 356-5750
Shipping: 2300 Experiment Station Road

times and two threshold temperatures, were designed to apply different amounts of water as shown in Table 1.

Three treatments were based on weekly measurements of profile water content from the surface to the maximum 5-foot rooting depth of soybean in the Pullman soil (Table 1). For the 100% treatment, irrigation was applied to make up the difference between measured profile water content and the profile water content to 5-foot depth at field capacity (18.7 in., or 31.6% volumetric water content). Water content was measured by neutron scattering in a single access tube in each plot. Measurements were taken from 0.1-m to 2.3-m depth in 0.2-m increments. The neutron moisture gauge (Campbell Pacific Nuclear International, model 503DR) was calibrated as reported by Evett and Steiner (1995). The mean root zone water content for the three 100% plots was used to calculate irrigation depth for that treatment, and the 67% and 33% treatments were given 67% and 33% of that depth, respectively.

Table 1. Irrigation scheduling treatments on soybean at Bushland, TX, 1996.

Treatment Name	BIOTIC Treatments: Threshold Temperature (EC)	Threshold Time (min)	Relative Irrigation Amount
27/27	27	256	Intermediate
27/29	27	171	Most
29/29	29	171	Intermediate
29/27	29	256	Least
	Profile Water Content Treatments		
100%	Refill five foot profile to field capacity weekly.		
67%	Apply 67% of amount applied to the 100% treatment.		
33%	Apply 33% of amount applied to the 100% treatment.		

Table 2. Drip irrigated soybean yields at Bushland, TX, 1996.

Treatment	Mean Yield (bu/ac)	
29/29	80.2	A†
29/27	78.4	A
27/27	75.4	A
27/29	74.5	A B
100%	74.3	A B
67%	68.2	B C
33%	60.8	C

†Identical letters indicate no statistical difference at P = 0.05.

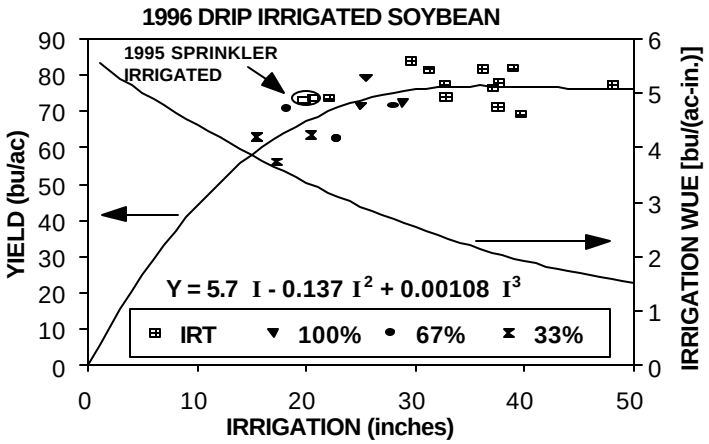


Figure 2. Yield vs. irrigation for soybean grown under surface and subsurface drip irrigation at Bushland, TX, 1996. In the equation, Y is yield (bu/ac) and I is total depth of irrigation (inches).

RESULTS

Yields under these well-watered conditions approached 80 bu/ac (Table 2), nearly doubling those typically obtained in the Southern High Plains (Salisbury et al., 1998). There was no significant difference in yield between any of the BIOTIC treatments and the 100% treatment, although the most stressful BIOTIC treatment (29/29) out yielded the 100% treatment by 5.9 bu/ac. The 33% treatment yielded significantly less (60.8 bu/ac)

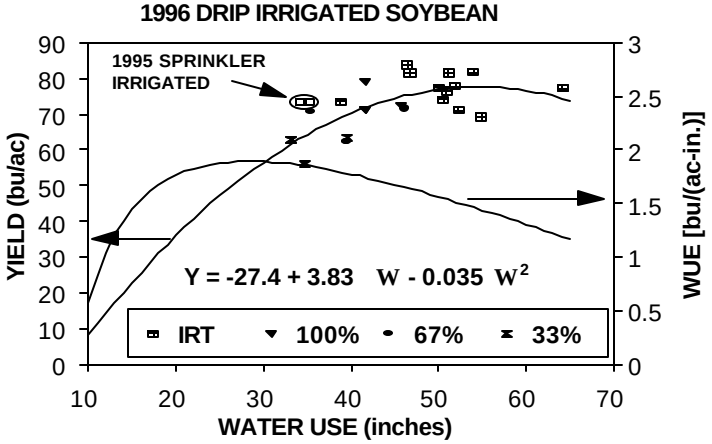


Figure 3. Soybean yield and water use efficiency measured at Bushland, TX, 1996, under surface and subsurface drip irrigation. In the equation, Y is yield in bu/ac and W is total water use (consumptive use) in inches.

than any other treatment, but the 67% treatment did so with just 17.7 inches applied water. Among the BIOTIC treatments, higher yields were obtained with the 29/29 treatment. It appeared that more than 30 inches of irrigation water applied may have reduced yield and certainly did not increase yield (Fig. 2). A second order polynomial fitted to the data, with the intercept taken as zero, described yield vs. irrigation depth well. There were 16.2 inches of rain between planting and harvest, five inches above normal for this period. Plotting yields and irrigation amounts for soybean grown at Bushland in 1995 under sprinkler irrigation shows fair agreement with the polynomial (Fig. 2). Somewhat less irrigation was needed in 1995 due to good seed bed moisture conditions at planting, and due to the even soil wetting for germination obtained with the low pressure spray irrigation system used for that study.

Yield vs. total water use was described well by a second order polynomial with a negative intercept, which indicates that yield would reach zero before water use (Fig. 3). The data indicate that yields of 60 bu/ac are attainable with about 33 inches total water use. The 58 year mean rainfall during the months May through August at Bushland is 11.2 in. Assuming that the timing of summer rains was not too disadvantageous, and that the soil had good water holding capacity so that little rain was lost to deep percolation, one could expect to need 22 in of irrigation on average to obtain 60 bu/ac. Plotting yield and water use for soybean grown at Bushland under sprinkler irrigation in 1995 shows fair agreement with the polynomial (Fig. 3). The extra water used in 1996 was likely all due to the excess water needed for germination.

The BIOTIC method performed well once the soybean canopy developed enough that its temperature could be measured by IRT. However, due to slow crop development, nearly two months of the growing season passed before the BIOTIC method could be implemented on July 3. By coincidence, in 1998 the BIOTIC method was again implemented for soybean irrigation on July 3. As in 1996, spring weather in 1998 was very dry, germination required excess water from the drip system, and crop development was slow.

REFERENCES

Evett, S.R., and J.L. Steiner. 1995. Precision of neutron scattering and capacitance type moisture gages based on field calibration. *Soil Sci. Soc. Amer. J.* 59:961-968.

Howell, T.A., A.D. Schneider, and S.R. Evett. 1997. Subsurface and surface microirrigation of corn - Southern High Plains. *Trans. ASAE* 40(3):635-641.

Lascano, R.J., R.L. Baumhardt, S.K. Hicks, S.R. Evett, and J.L. Heilman. 1996. Daily measurement and calculation of crop water use. pp. 225-230 *In* C.R. Camp, E.J. Sadler, and R.E. Yoder (eds.) *Proceedings of the International Conference on Evapotranspiration and Irrigation Scheduling*. Nov. 3-6, 1996, San Antonio, TX, U.S.A. 1166 pp.

Salisbury, C., B. Bean, and T. Marek. 1998. Result demonstration report, 1997 soybean variety trial in the Texas Panhandle. Texas A&M University, Texas Agricultural Extension Service, Amarillo, TX.

Wanjura, D.F., D.R. Upchurch, and J.R. Mahan. 1995. Control of irrigation scheduling using temperature-time thresholds. *Trans. ASAE* 38(2):403-409.

Irrigated Area in the Texas High Plains Greatly Exceeds Projections . . .

by Arland D. Schneider

As ground water declines in the Ogallala aquifer became more pronounced in the 1960s, a major, long-term decline in irrigated acres was predicted by Hughes and Harman (1969). They developed a computer simulation model that maximized annual net return to irrigation farmers in High Plains Water District No. 1, and with the model predicted the decline in irrigated acres illustrated in Fig. 1. As the water table and pumping rates declined, land that was no longer profitable to irrigate because of insufficient water was returned to dryland production. They predicted that irrigated acreage would decline from 3.5 million acres in 1966 to 125,000 acres in 2015. Over the same interval, they predicted a ground water pumping decline from 4.13 million to 95,000 acre-feet. The 96% decline in irrigated land area would be accompanied by substantial

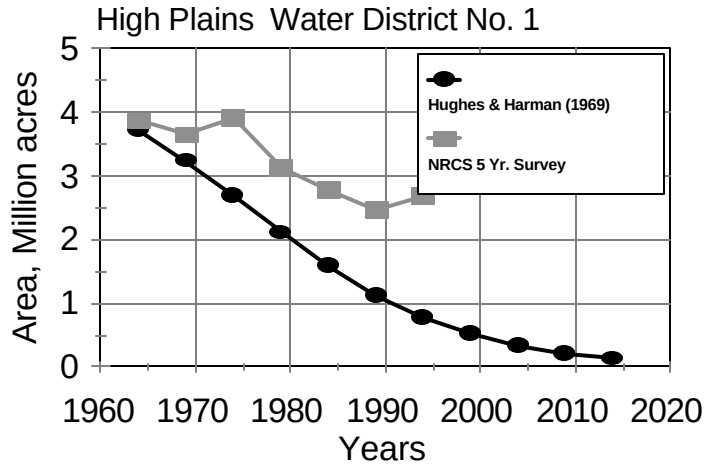


Figure 1. Projected and measured irrigated areas in the High Plains Underground Water District No. 1.

reductions in crop production and agricultural income and likely major reductions in land values.

Since the projection by Hughes and Harman (1969), the USDA-Natural Resource Conservation Service (formerly USDA-Soil Conservation Service) has conducted irrigation acreage surveys every 5 years, Fig. 1. The measured irrigated acreage in the Hughes and Harman study area actually rose to an all-time high of 3.92 million acres in 1974. After that, it declined to 2.48 million acres in 1989 and then rebounded slightly to 2.69 million acres in 1994. The measured acreage decline is not nearly as rapid as the predicted decline, and suggests that irrigated production in the study area will continue at much higher levels for some time to come. The 1964 to 1989 NRCS data have been summarized by Musick et al. (1990), but the individual county figures used to plot the NRCS curve in Fig. 1 are unpublished data of Jack T. Musick. For the entire Texas High Plains, irrigated acres have also followed the trend of the NRCS data for the High Plains Water District No. 1.

The Hughes and Harman study area included all or part of 21 counties that comprise High Plains Underground Water Conservation District No. 1. This area extends north to south from Amarillo to slightly south of Lubbock and from the New Mexico state line on the west to the caprock on the east. A linear programming model was used to maximize net returns to irrigation programs under 1966 cost-price levels, production controls and price support programs. Primary crops in the area were cotton, grain sorghum and wheat. The study area was divided into numerous resource areas depending on depth to the static water level, saturated thickness of the aquifer, soil type and the primary crops. Irrigation in each resource area was projected to continue until the net return to capital, land, management and operator labor was equal to that of the same farm operated as a dryland farm. Land that was no longer profitable to irrigate returned to dry-farmed production with no land reverting to pasture or rangeland.

Since the 1969 projection, numerous forces, in addition to the water table decline, have caused the actual irrigated acres to deviate from the projected acres. The peak irrigated acreage in 1974 was influenced by the sharp increase in commodity prices in the early 1970s. At the same time, energy prices remained stable and fairly low by more recent comparisons. Later in the 1970s and early 1980s, energy prices increased dramatically while commodity prices declined. These forces along with the Conservation Reserve Program starting in the late 1980s contributed to the 1.44 million acre decline from 1974 to 1989. The slight recovery to 2.69 million acres in 1994 was influenced by a better balance of commodity and energy prices and increased use of center pivot irrigation systems.

The 30-year NRCS data base allows some basic generalizations about the decline of irrigated area in the Texas High Plains. Without doubt, irrigated acres peaked about 1974, and since, have entered a long-term decline. This decline, however, is not nearly as rapid or constant as that projected by Hughes and Harman (1969). For example, the measured area was 3½ times as great as the projected area in 1994 and will likely will be about 5 times as great in 1999. Over short intervals, commodity and energy prices, government programs and the weather will accelerate or decelerate the effect of the declining Ogallala water table. Over the long term, increased irrigation efficiency from sprinkler and drip irrigation will decelerate the decline. In summary, irrigation in the Texas High Plains will continue to be a major contributor to both production agriculture and the entire economy for several decades into the future.

REFERENCES

Hughes, W.F., and W.L. Harman. 1969. Projected economic life of water resources, Subdivision Number 1 High Plains Underground Water Reservoir. Texas Agr. Exp. Sta. Tech. Mono. 6, Texas A&M Univ., College Station, TX.

Musick, J.T., F.B. Pringle, W.L. Harman, and B.A. Stewart. 1990. Long term irrigation trends - Texas High Plains. *Appl. Eng. in Agr.* 6(6):717-724.

Is 1998 a Normal Year? . . .

by Terry Howell

This may turn out to be true, but

*"...it depends on what **is** means."*

[...President Bill Clinton, 1998].

In my 16-yr tenure on the Texas High Plains, this 1998 growing season at Bushland was the most challenging I've experienced and certainly far from typical. A few miles away, rainfall during this period was near normal (whatever that means). Whether it is due to El Niño or La Niña will be sorted out by the climatologists. All I know is that it didn't rain much at Bushland this summer, and we measured some of the largest evapotranspiration rates ever (and maybe world records).

The 1998 year through October and the summer (April through September) precipitation amounts for the NP-PET weather station sites are given in Table 1. The stations are listed in blocks from north to south and west to east within each block for those not familiar with these town names. At most locations, over-winter and early spring precipitation appeared promising through March. The northern areas, generally, received normal to above normal growing season precipitation, but the central and southwestern areas of the Texas High Plains experienced one of their driest summers on record. The 1998 Bushland monthly precipitation totals (Fig. 1) illustrate this trend. Through March, Bushland had received 4.47 in., which

Table 1. Precipitation totals for 1998 from the NP-PET weather station sites. Data are in inches.

Site	Jan.-Oct.	Apr.-Sept.
Dalhart	15.96	8.68
Etter	19.28	9.55
Morse	19.17	5.84
Perryton	18.09	9.63
ARS-Bushland	14.86	3.06
TAES-Bushland	15.02	3.26
White Deer	21.78	8.10
Wellington	19.33	4.68
Farwell	13.34	4.95
Dimmitt	11.50	2.62
Earth	12.53	5.81

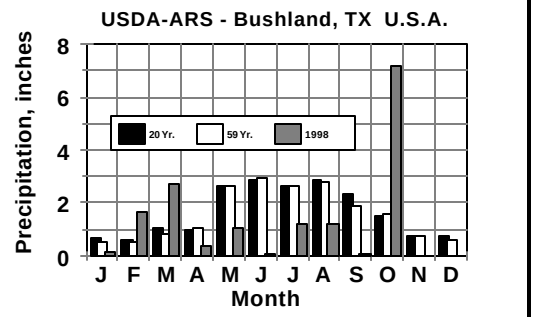


Figure 1. Mean monthly precipitation at Bushland, TX, for the past 20- and 59-year periods compared with that received in 1998 (through October).

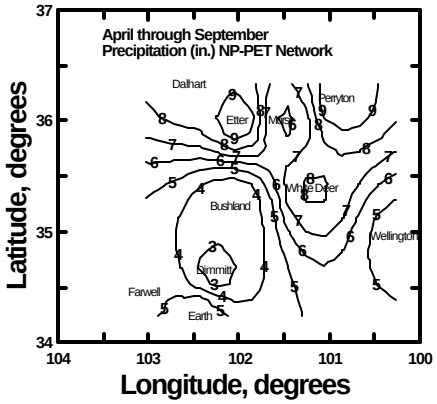


Figure 2. April through September precipitation totals for the Northern Texas High Plains.

was 192% of the 20-year mean and 245% of the 59-yr mean. But fortunes reversed beginning in April. For the April through September time period, Bushland precipitation was only 27% and 28% of the 20- and 59-yr means. In fact, both June and September monthly precipitations were less than 0.06 inches each. October precipitation was the third wettest in the rainfall amount of 4.55 in. reported for Oct. 31 was the largest 24-hr (8 am to 8 am) rainfall ever measured at Bushland. Figure 2 shows the April through September rainfall contours for the northern Texas High Plains.

Daily evapotranspiration (ET) rates of irrigated alfalfa measured with two weighing lysimeters at Bushland during the 1998 summer are shown in Figure 3 through late July. The extremely large measured daily ET rates in mid to late June (DOYs 160 to 175), just prior to the second hay cutting, are indicative of the hot, dry, and windy weather. On DOY 164, ½ hour mean 2-m wind speed over the 24-28 in. (0.6-0.7 m) tall alfalfa exceeded 22 mph (10 m/s) for most of the mid day. At the same time, the vapor pressure deficit at 2-m over the irrigated alfalfa exceeded 40 mbar (4 kPa). The maximum ET rates (measured for ½ hour periods) on DOY 164 were nearly 0.071 in./hr (1.8 mm/hr) and the daily ET was 0.69 in. (17.6 mm). On DOY 165 with almost identical solar radiation but lower VPDs (about 3 kPa or 30 mbar) and much lower winds (usually less than 7 mph or 3 m/s during the day), peak ET rates slightly exceeded 0.035 in./hr (0.9 mm/hr) and the daily ET was 0.39 in. (9.9 mm). Nearly identical circumstances occurred on DOYs 171 and 172 with daily ET amounts of 0.63 in. (16.0 mm) and 0.36 in. (9.1 mm)., respectively.

The daily ET version of the Penman-Monteith equation (Jensen et al., 1990) performed well with the "standardized" alfalfa canopy resistance of 45 s/m and their characterizations for the aerodynamic resistance. However, on a diurnal basis, the canopy resistance was more consistently in the 20-25 s/m range (Todd et al., 1998a,b).

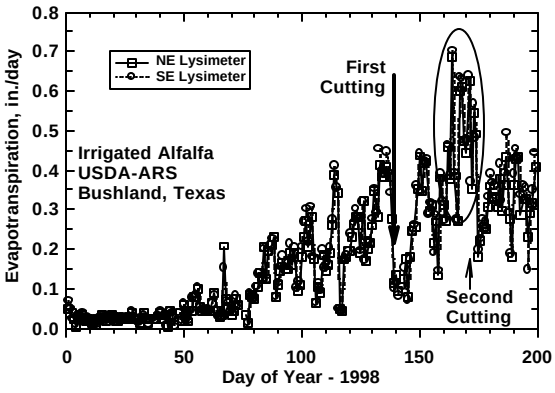


Figure 3. Measured daily ET of irrigated alfalfa at Bushland, TX, during the 1998 summer.

These very large ET rates coupled with the lack of precipitation combined to make the 1998 growing season anything but "normal." **BUT being non-normal *is normal* for the Texas High Plains**.

REFERENCES

Jensen, M.E., R.D. Burman, and R.G. Allen (ed.). 1990. Evapotranspiration and irrigation water requirements. ASCE Manuals and Reports on Engineering Practice No. 70, Am. Soc. Civil Engr., New York, NY. 332 p.

Todd, R.W., S.R. Evett, and T.A. Howell. 1998a. Latent heat flux of irrigated alfalfa measured by weighing lysimeter and Bowen ratio-energy balance. ASAE Paper 98-2119.

Todd, R.W., S.R. Evett, T.A. Howell, and J.A. Tolk. 1998b. Canopy surface and stomatal resistance of alfalfa in a semi-arid environment. Agron. Abs. p. 16.

ERRATA . . .

In Vol. 2, No. 1, the article by Rick Todd entitled *Exploring the Anatomy of ET*, gave the impression that the FAO-PM (Food and Agriculture Organization of the U.N., Penman-Monteith) reference ET equation was for alfalfa when in fact it is for grass. Rick was referring to the alfalfa reference ET equation available in the cited paper by Allen et al. (1989) or in ASCE Manual No. 70.

NEWSLETTER . . .

The *Wetting Front* newsletter is designed to foster technology transfer from our research to industry and to agricultural producers in the Southern High Plains and to improve communications with our stakeholders and partners. For actions or corrections to our mailing list, contact Mrs. Carole Perryman by fax [(806) 356-5750], e-mail (cperryma@ag.gov), phone [(806) 356-5749], or mail [USDA-ARS, P.O. Drawer 10, Bushland, TX 79012]. The *Wetting Front* can also be found on the WWW at http://www.cprl.ars.usda.gov/wmru/wfront.htm. Any suggestions or comments are welcome too.

AWARDS & RECOGNITIONS . . .

Steve Evett, Soil Scientist, was promoted by the ARS-RPES review panel. **Jim Cresap**, Biological Technician, was promoted.

Don Dusek, Agronomist, was notified that he was selected as the ***Support Scientist of the Year***, by the ARS Southern Plains Area. The award will be presented to Don at the upcoming SPA Leadership Conference in Stuttgart, AR. It was for his *"outstanding contributions to irrigation research and for developing automated programs for the North Plains PET Network."*

Steve Evett, Soil Scientist, received a President's Citation from the Texas Council of Chapters, Soil & Water Conservation Society.

Keith Brock received an *Extra Effort Spot Award* for his outstanding performance in scheduling irrigations and maintenance of the Laboratory irrigation system in this major drought year. **Jim Cresap, Brice Ruthardt, Rob Robertson, Gary Marek, Sara Ledbetter,** and **Kyle Schniederjan** received *Extra Effort Spot Awards* for their outstanding performance in keeping the plots irrigated and maintained in this extremely dry summer. **Carole Perryman** received an *Extra Effort Spot Award* for her part in preparing the **1998 Bushland Ag Day Booklet** for our 60th anniversary field day.

Terry Howell received the **American Society of Civil Engineers Royce J. Tipton Award for 1998** at the ASCE Water Resources Engineering Conference August 3-7, 1998, in Memphis, TN. He also was elected as Chair-Elect of the Agroclimatology and Agronomic Modeling (A-3) Division of the American Society of Agronomy.

Brice Ruthardt and **Jim Cresap** received *Superior Performance Awards.* **Steve Evett** received an *Outstanding Performance Award*, and **Terry Howell** received a *Superior Performance Award*.

INTERNET NEWS . . .

The Southern Plains Area Office web site has a page describing the activities honoring Hispanic Heritage Month and the dedication and renaming of the Weslaco Laboratory to the **Kika de la Garza Subtropical Agricultural Research Center** at http://www.spa.ars.usda.gov/area_spa_hh.htm.

The ARS ***FIND the EXPERT*** site at http://alembic.nal.usda.gov:9500/NPS/expert.htm can help you locate ARS experts that can provide assistance.

Information on ARS **National Programs** can be located at the *updated* NPS web site at http://www.nps.ars.usda.gov/.

Download the **ARS Screen Saver** from the http://www.ars.usda.gov/other.html page or visit the **ARS Science Hall of Fame** at http://www.ars.usda.gov/hof/. The on-line version of the ***Agriculture Research*** magazine can be

located at http://www.ars.usda.gov/is/AR/. The *new* ARS **Science 4 Kids** page provides many interesting facts about agriculture and research at http://www.ars.usda.gov/is/kids/

The Texas Tech University Department of Plant and Soil Science at http://www.pssc.ttu.edu/ provides useful information.

Updated TDR software for soil water measurement and information on calibrating and use of neutron probes for soil water measurement may be found at http://www.cprl.ars.usda.gov/programs/.

GRANT NEWS . . .

Work is progressing on the ATUT project with Egypt. Dr. Evett has installed equipment for soil water measurement together with the lysimeters at Ismalia. Dr. Rick Todd has made significant progress on ET measurements for the ATUT project (funded by USDA-FAS through USAID).

Arland Schneider and Terry Howell are co-investigators with Dr. Guy Fipps, Texas Agricultural Extension Service, and Dr. Donald Reddell, Texas Agricultural Experiment Station, and Dr. Attila Yazar, Dr. Kenan Diker, Dr. Riza Kanber, Dr. Mujde Koc, Dr. Bulent Ozekycy, Metin Sezen, and Dr. Oguz Yurdakul, Cukurova University in Turkey, on a project proposal entitled "*Irrigation Technology Introduction, Adoption and Management for Natural Resources Preservation in the Southeast Anatolia Project (GAP) in Turkey"* submitted to the National Science Foundation.

UPCOMING EVENTS, MEETINGS, AND PRESENTATIONS . . .

UPCOMING MEETINGS & PRESENTATIONS

- **Nov. 30-Dec. 2, 1998** the State Space Analysis and Other Spatial Statistics and its Application to Precision Agriculture workshop in Lubbock, TX, sponsored by the Texas Agricultural Experiment Station.

- **December 1, 1998** TAIA Banquet, Ambassador Hotel, Amarillo, TX [rsvp by Nov. 24th @ 806-665-2838].

- **December 1-3, 1998** Amarillo Farm and Ranch Show, Amarillo Civic Center, Amarillo, TX.

- **January 12, 1999** High Plains Irrigation Conference & Trade Show, Amarillo Civic Center, Amarillo, TX.

- **February 9-11, 1999** the Central Plains Irrigation Conference and Short Course, Sterling, CO.

- **February 21-23, 1999** the 21st Biennial Grain Sorghum Research and Utilization Conference, Tucson, AZ.

- **March 10-13, 1999** the USCID Conference on Benchmarking Irrigation System Performance Using Water Measurement and Water Balances, San Luis Obispo, CA.

- **March 30 - April 1, 1999** the SPA Leadership Conference at Stuttgart, AR [Terry Howell, Don Dusek, and Carole Perryman].

- **April 13-14, 1999** the Third Workshop on Electromagnetic Wave Interaction with Water and Moist Substances at Athens, GA.

- **June 1999** Texas Soil & Water Conservation Society Meeting, Kerrville, TX.

- **July 18-21, 1999** ASAE/CSAE-SCGR International Meeting, Toronto, Canada.

- **August 8-11, 1999** the SWCS Annual Conference, Biloxi, MS.

- **August 8-11, 1999** the International Water Resources Engineering Conference, Seattle, WA.

- **October 18-22, 1999** the USICD Conference on Modernization of Irrigation Water Delivery Systems, Phoenix, AZ.

- **October 31-November 4, 1999** ASA/CSSA/SSSA Annual Meeting, Salt Lake City, UT.

- **June 20-24, 2000** the USCID International Conference on the Challenges Facing Irrigation and Drainage in the New Millennium, Fort Collins, CO.

- **November 5-9, 2000** ASA/CSSA/SSSA Annual Meeting, Minneapolis, MN.

RECENT PRESENTATIONS

- **May 26-29, 1998**
ARS Irrigation & Drainage Workshop, Ft. Collins, CO.

On-Farm Irrigation Issues
. . . . . T.A. Howell

- **July 12-16, 1998**
American Society of Agricultural Engineers Meeting
Orlando, FL.

Latent Heat Flux of Alfalfa Measured by Weighing Lysimeters and Bowen Ratio Energy Balance
. . . . . R.W. Todd, S.R. Evett, & T.A. Howell

Evapotranspiration of Irrigated Alfalfa in a Semi-Arid Environment . . . . . S.R. Evett, T.A. Howell, R.W. Todd, ... A.D. Schneider, & J.A. Tolk

Evapotranspiration of Irrigated Fescue Grass in a Semi-Arid Environment
. . . . . T.A. Howell, S.R. Evett, A.D. Schneider, & J.A. Tolk

n Aug. 3-7, 1998 ASCE International Water Resources Engineering Conference & Groundwater Management Symposium, Memphis, TN

A Texas Sized Test of the ASCE ET Equation [the Tipton Lecture]
. . . . . T.A. Howell

n Oct. 18-22, 1998
ASA/CSSA/SSSA Meetings, Baltimore, MD.

Soil Type Effects on Crop Soil Water Extraction and Water Stress . . . . . J.A. Tolk, T.A. Howell, & S.R. Evett

Water Use Efficiency of Corn in the U.S. Southern High Plains
. . . . . T.A. Howell & J.A. Tolk

Canopy Stomatal and Surface Resistance of Irrigated Alfalfa in a Semi-Arid Environment
. . . . . R.W. Todd, S.R. Evett, T.A. Howell, & J.A. Tolk

Laboratory Calibration and Evaluation of Multisensor Capacitance Soil Water Probes
. . . . . R.L. Baumhardt, R.J. Lascano, & S.R. Evett

n Oct. 22-23, 1998
Texas Section of ASAE, San Marcos, TX.

Irrigation on the Texas High Plains
. . . . . A.D. Schneider

TECHNOLOGY TRANSFER NEWS . . .

Customer/Clientele/Producer Meetings/Seminars:

Steve Evett presented *Infrared Remote Sensory Methods* to the North Plains Field Day at Etter, TX, on May 21, 1998. **Judy Tolk** and **Terry Howell** attended the field day.

Terry Howell, Steve Evett, Arland Schneider, and **Judy Tolk** attended and participated in the ARS Workshop, *Irrigation and Drainage in Harmony with the Environment*, in Fort Collins, CO, on May 26-29, 1998. **Terry Howell** presented *On-Farm Irrigation Practices*.

Steve Evett, Judy Tolk, and **Arland Schneider** were organizers and worked on local arrangements for the 1998 Texas Soil & Water Conservation Society meeting in Amarillo on June 17th-19th. **Steve Evett** chaired the organizing committee; **Judy Tolk** organized and chaired the session on *Water in the 21st Century – Rights and Realities*; **Arland Schneider** was the treasurer; and **Carole Perryman** helped with pre-registrations and on-site registration. **Terry Howell, Rick Todd**, and **Karen Copeland** attended the meeting.

Steve Evett and **Arland Schneider** made tour stop presentations at the *1998 Bushland Ag Day* on August 12th. **Terry Howell** served as chair of the planning committee; **Arland Schneider** organized the exhibitors; and **Judy Tolk** and **Rick Todd** were tour bus guides.

Terry A. Howell presented the seminar on the *Texas High Plains PET Network* to the Biological Systems Engineering Department, Irrigation Group, at the University of Nebraska, Lincoln on September 14, 1998.

Steve Evett made a presentation at the 1998 Bushland Soybean Field Day on September 15th.

Steve Evett was *invited* to attended the Second Workshop to develop Chapter 4 of the Dept. of Energy Vadose Zone State-of-the-Art Knowledge book in Las Vegas, NV on Sept. 22nd-23rd.

Steve Evett presented a talk and field demonstration on soybean and alfalfa irrigation at Bushland, TX, on Oct. 15th to an Irrigation and Precision Agriculture Tour Group from Nevada and California.

Steve Evett was *invited* to participate in the Consultants' Meeting on Three Methods of Soil Water Content Measurement in Vienna, Austria on Nov. 22-25.

Media Contacts:

Press releases about the SWCS meeting appeared in the *Amarillo Globe News*, *Lubbock Avalanche Journal*, and the HPUWCD *Cross Section*.

Press releases and follow-up news articles appeared in the *Amarillo Globe News* about the 1998 Bushland Ag Day. All local TV stations carried news stories about the field day. KGNC (710 AM in Amarillo) broadcasted a taped interview with

Dr. Floyd Horn, ARS Administrator, on the noon Ag Program on August 13th.

Visitors:

Dr. Ken Hubbard and **Dalziza de Oliveira**, University of Nebraska and the School of Natural Resource Sciences, visited on June 2nd-5th, and Dalziza remained at Bushland the following week for training on lysimeters.

Dr. Bill Payne and **Dr. Don Wysocki**, Oregon State University, Columbia Basin Agricultural Research Center at Pendleton, OR, visited on June 3rd about rain shelter designs.

Hobert Shaffer and **Lee Gates**, Premium Standard Farms, visited on Aug. 18th.

Dr. Gary Ham, Bureau of Sugar Experiment Stations, from Ayr, Qld., Australia, visited on Aug.19 & 20th.

Drs. Laj Ahuja and **MarvShafer** together with **Ken Rojas** and **Dr. Liwang Ma** visited Bushland and presented an interactive training course on RZWQM (root zone water quality model) to the CPRL staff on Aug. 19th-21st.

U.S. Congress Representative Mac Thornberry (TX-Dist. 13) and **Louis Britt** visited the CPRL on Sept. 2nd.

Popular Magazine Articles:
none to report

CRADA/Inter-Agency Collaboration:
none to report

Other Technology Transfer Activities:

Rick Todd presented a career day program to Southlawn Elementary School (AISD) on May 19th.

Steve Evett, Arland Schneider, and **Terry Howell** made presentations to the 1998 Dryland Workshop and Tour from WTAMU on June 11th & 25th.

Judy Tolk made a presentation on global position system accuracy to a WTAMU graduate class on Aug. 5th and **Steve Evett** presented a talk on remote sensing and IRT's.

Steve Evett helped prepare and assemble a display on soil particle size/texture/sedimentation for the Children's Science Exposition at the Tri-State Fair in Amarillo, TX on Sept. 19th-26th.

Steve Evett, Arland Schneider, and **Terry Howell** made presentations to the Water Management class at WTAMU on Oct. 28th.

Terry Howell serves on the Ph.D. committees of Dalziza de Oliveira and Qingwu Xu at the University of Nebraska.

PUBLICATIONS
(since May 1998) . . .

Baumhardt, R.T., R.J. Lascano, and S.R. Evett. 1998. Laboratory calibration and evaluation of multisensor capacitance soil water probes. Agron. Abs. p. 176.

Evett, S.R. 1998. Coaxial multiplexor for time domain reflectometry measurement of soil water content and bulk electrical conductivity. *Trans. ASAE* 41(2):361-369.

Evett, S.R. 1998. The TACQ computer program for automatic measurement of water content and bulk electrical conductivity using time domain reflectometry. ASAE Paper No. 98-3192.

Evett, S.R., T.A. Howell, R.W. Todd, A.D. Schneider, and J.A. Tolk. 1998. Evapotranspiration of irrigated alfalfa in a semi-arid environment. ASAE Paper 98-2123.

Howell, T.A. 1998. Using the PET network to improve irrigation water management. pp. 38-45. *In* L.L. Triplett (ed.) *The Great Plains Symposium 1998: The Ogallala Aquifer, Determining the Value of Water*. The Great Plains Foundation, Overland Park, KS.

Howell, T.A., and J.A. Tolk. 1998. Water use efficiency of corn U.S. Southern High Plains. Agron. Abs. p. 14.

Howell, T.A., J.A. Tolk, A.D. Schneider, and S.R. Evett. 1998. Evapotranspiration, yield, and water use efficiency of two different maturity corn hybrids. *Agron. J.* 90:3-9.

Howell, T.A., S.R. Evett, A.D. Schneider, R.W. Todd, and J.A. Tolk. 1998. Evapotranspiration of irrigated fescue grass in a semi-arid environment. ASAE Paper 98-2117.

Schneider, A.D., and T.A. Howell. 1998. LEPA and spray irrigation of corn — Southern Great Plains. *Trans. ASAE* 41(5): 1391-1396.

Schneider, A.D., T.A. Howell, A.T.A. Moustafa, S.R. Evett, and W. Abou-Zeid. 1998. A simplified weighing lysimeter

for developing countries. *Applied Engr. in Agric.* 14(3):267-273.

Todd, R.W., S.R. Evett, and T.A. Howell. 1998. Latent heat flux of irrigated alfalfa measured by weighing lysimeter and Bowen ratio-energy balance. ASAE Paper 98-2119.

Todd, R.W., S.R. Evett, T.A. Howell, and J.A. Tolk. 1998. Canopy surface and stomatal resistance of irrigated alfalfa in a semi-arid environment. Agron. Abs. p. 16.

Tolk, J.A., T.A. Howell , and S.R. Evett. 1998. Evapotranspiration and yield of corn grown in three High Plains soils. *Agron. J.* 90:447-454.

Tolk, J.A., T.A. Howell, and S.R. Evett. 1998. Soil type effects on crop soil water extraction and water stress. Agron. Abs. p. 15.

PERSONNEL NEWS . . .

Authur B. (Rob) Robertson III resigned as Biological Technician (soils) in October.

Steve Evett attended radiation safety training for Neutron/Density Gauges at Campbell Pacific Nuclear International at Martinez, CA, on Sept. 9-11, 1998.

The Water Management Research Unit depends heavily on our summer employees. In 1998, **Kyle Schniederjan** (WTAMU), ***Sara Ledbetter*** (Amarillo College), ***Gary Marek*** (WTAMU), and ***Kevin von Netzer*** (WTAMU graduate school) worked for our unit. Kyle, Gary, and Kevin are working part-time this fall while attending school. Sara is also working part-time for ESAWRU. ***Kevin von Netzer*** was married this summer and worked as an environmental intern for Phillips Petroleum in Borger during the summer.

Terry Howell completed his assignment as chair of the ASA/CSSA/SSSA Feasibility Committee to consider an update to Agronomy Monograph No. 30 *Irrigation of Agricultural Crops.*

Judy Tolk is scheduled to attend the OPM training course on *Team Building and Leadership* in Denver, CO, on Nov. 30-Dec. 4, 1998.

Steve Evett and **Terry Howell** are scheduled to attend the *State Space Analysis and Other Spatial Statistics and its Application to Precision Agriculture* workshop in Lubbock, TX, on Nov. 30-Dec. 2, 1998 sponsored by the Texas Agricultural Experiment Station.

Arland and **Lorri Schneider** are the proud parents of David Joseph born on July 16th. David's older sister is Sydney.

SCIENTIFIC JARGON . . .

by Dyrk Schingman
Oregon State University

After several years of studying and hard work, I have finally learned scientific jargon. The following list of phrases and their definitions will help you to understand that mysterious language of science and medicine.

"IT HAS LONG BEEN KNOWN"
... I didn't look up the original reference.

"A DEFINITE TREND IS EVIDENT"
...These data are practically meaningless.

"WHILE IT HAS NOT BEEN POSSIBLE TO PROVIDE DEFINITE ANSWERS TO THE QUESTIONS"
... An unsuccessful experiment, but I still hope to get it published.

"THREE OF THE SAMPLES WERE CHOSEN FOR DETAILED STUDY"
... The other results didn't make any sense.

"TYPICAL RESULTS ARE SHOWN"
... This is the prettiest graph.

"THESE RESULTS WILL BE IN A SUBSEQUENT REPORT"
... I might get around to this sometime, if pushed/funded.

"THE MOST RELIABLE RESULTS ARE OBTAINED BY JONES"
... He was my graduate student, his grade depended on this.

"IN MY EXPERIENCE"
... once

"IN CASE AFTER CASE"
... Twice

"IN A SERIES OF CASES"
... Thrice

"IT IS BELIEVED THAT"
... I think.

"IT IS GENERALLY BELIEVED THAT"
... A couple of other guys think so too.

"CORRECT WITHIN AN ORDER OF MAGNITUDE"
... Wrong.

"ACCORDING TO STATISTICAL ANALYSIS"
... Rumor has it.

"A STATISTICALLY ORIENTED PROJECTION OF THE SIGNIFICANCE OF THESE FINDINGS"
... A wild guess.

"A CAREFUL ANALYSIS OF OBTAINABLE DATA"
... Three pages of notes were obliterated when I knocked over a glass of beer.

"IT IS CLEAR THAT MUCH ADDITIONAL WORK WILL BE REQUIRED BEFORE A COMPLETE UNDERSTANDING OF THIS PHENOMENA OCCURS"
... I don't understand it.

"AFTER ADDITIONAL STUDY BY MY COLLEAGUES"
... They don't understand it either.

"THANKS ARE DUE TO JOE BLOTZ FOR ASSISTANCE WITH THE EXPERIMENT AND TO ANDREA SCHAEFFER FOR VALUABLE DISCUSSIONS"
... Mr. Boltz did the work and Ms. Schaeffer explained to me what it meant.

"A HIGHLY SIGNIFICANT AREA FOR EXPLORATORY STUDY"
... A totally useless topic selected by my committee.

"IT IS HOPED THAT THIS STUDY WILL STIMULATE FURTHER INVESTIGATION IN THIS FIELD"
... I quit.

This may be used or broadcast in any form as long as I receive credit.
--Dyrk Schingman

Water Management Research Unit

http://www.cprl.ars.usda.gov

RESEARCH STAFF

Dr. Terry A. Howell, P.E.
Research Leader (Agric. Engr.)
(806) 356-5746
tahowell@ag.gov

Dr. Steven R. Evett
Soil Scientist
(806) 356-5775
srevett@ag.gov

Ronald R. Allen
Collaborator (Agric. Engr.)
(806) 356-5725

Jack T. Musick
Collaborator (Agric. Engr.)
(806) 356-5769

Dr. R. Nolan Clark
Laboratory Director (Agric. Engr.)
(806) 356-5734
rnclark@ag.gov

Dr. Arland D. Schneider, P.E.
Agricultural Engineer
(806) 356-5732
aschneid@ag.gov

Karen S. Copeland
Soil Scientist
(806) 356-5735
kacopeland@ag.gov

Dr. Richard W. Todd
Plant Physiologist
(806) 356-5728
rtodd@ag.gov

Donald A. Dusek
Agronomist
(806) 356-5747

Dr. Judy A. Tolk
Plant Physiologist
(806) 356-5736
jtolk@ag.gov

USDA United States Department of Agriculture

ARS Agricultural Research

POSTMASTER: Send address changes to *Wetting Front*, USDA-ARS, P.O. Drawer 10 Bushland, TX 79012-0010.

USDA-ARS
P.O. Drawer 10
Bushland, TX 79012-0010